POTENTIAL RECEPTOR EVALUATION-MANGROVE LAND CRABS IN THE EFFLUENT CHANNEL AREA AT THE COMMONWEALTH OIL AND REFINING COMPANY SITE PEÑUELAS, PUERTO RICO

Prepared for:

Commonwealth Oil and Refining Company
600 Road 127,
Peñuelas, Puerto Rico 00624-7501

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Prepared by:

On-Site Environmental, Inc.
PO Box 249
Dorado, Puerto Rico 00646
Tel. (787) 278-0563
Fax (787) 278-0560

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1.0 Site Description & Scope of Work

1.1 Site Description

The Commonwealth Oil and Refining Company Incorporated (CORCO) is located at Route 127, Municipio de Penuelas, Puerto Rico (site). The CORCO facility has been divided into separate areas in previous investigations based on facility operations and the nature of impact. This study was limited to the effluent channel area displayed in Figure A-1.

The CORCO effluent drainage ditch is approximately 3,900 feet long and extends from the guillotine valves in the main site area and flows due south to the Tallaboa Bay. The northern 1,600 feet of the effluent channel does not contain any vegetation (Sector 2). The downstream portion of the effluent channel is approximately 500 feet long and is densely populated with mangrove trees Sector 1). Soil samples were taken along the length of the effluent channel as part of a Phase II Environmental Site Assessment preformed by CSA Group in 2000. These samples were approximately 500 feet apart and are denoted as DD-SED-1 through DD-SED–9. The sediment samples were collected from a depth ranging from two (2) to four (4) feet below the surface of the effluent channel. Sample locations along the effluent channel from the CSA Phase II ESA are shown in Figure A-2.

On-site Environmental, Inc. (On-site) personnel traversed the site on July 21, 2005. At the time of the site visit, no land crabs or land crab burrows were noted. There was a petroleum sheen noted on the surface in Sector 2 only. No petroleum sheen was noted in Sector 1. Containment booms were located along the length of the effluent channel in equally spaced sequences as part of CORCO's spill control and monitoring practices. The petroleum sheen was apparently the result of a discharge of Number 6 fuel oil at the site just north of the effluent channel area, which occurred on March 20, 2005.

1.2 Scope of Work

The scope of work for this potential receptor evaluation consisted of reviewing data provided to On-Site Environmental, Inc. (On-Site) by CORCO, and evaluating the potential for humans to be affected by the consumption of land crabs originating from the effluent channel area. The chemicals of concern (COCs) evaluated in this study were limited to benzene, ethylbenzene, and xylenes. Additional volatile organic compounds (VOCs), poly-aromatic hydrocarbons (PAHs), metals, additives and other potential COCs may also be present.

2.0 Land Crab Description

The giant land crab *(Cardisoma guanhumi)* can measure up to 6in (15cm) across its carapace. In its juvenile form, colors range from dark brown, purple, or orange, to a bluish-gray color at maturity. Females sometimes appear light gray or white. One claw is larger than the other and the walking legs are sparsely hairy. Average total weight of adult land crabs can vary from 150 to 300 grams.

Cardisoma guanhumi ranges from Bermuda, throughout the Caribbean Sea, Texas and southern Florida. They can be found up to approximately five (5) miles from coastal waters. As adults, land crabs are terrestrial and return to the sea for drinking and breeding. They live in burrows at least deep enough to a level that will allow water to seep in for moisture.

Giant land crabs are primarily vegetarians and their primary diet consists of foliage, fruits, berries, flowers and some vegetables. Occasionally they will eat insects. *Cardisoma guanhumi* are exploited as a food source throughout the Bahamas and the Caribbean and populations have trends have indicated a decline. Puerto Rico has established a minimum size limit and prohibited harvesting blue land crabs during the main breeding period between July 15 and October 15. Crab harvesting in Puerto Rico state forests and reserves is prohibited.

3.0 Factors Affecting Organism Concentration

3.1 Bioavailability

Bioavailability is a measure of the potential for entry of the contaminant into ecological or human receptors and is specific to the receptor, the route of entry, time of exposure, and the soil matrix containing the contaminant (Anderson *et al*., 1999). The behavior and bioavailability of contaminants are greatly influenced by their interactions with soil parameters, such that not all contaminants are equally available to biota. However, estimating the availability of metals and organic contaminants in soil-to-soil biota and plant toxicity is not a straightforward process (USEPA, 2003). The bioavailablity of contaminants depends on their chemical properties and the specific physical and geochemical binding mechanisms that vary among contaminants and soil types. Contaminants interact with soil through interactions with the surface of particulate material in soils (adsorption), by penetration through the particulate surfaces where the contaminant becomes associated with the internal material (absorption or partitioning), and through specific contaminant reactions sometimes referred to as chemisorption (USPEA, 2003).

Contaminants are generally considered to be bioavailable when they are released from interactions with the soil and soil constituents and released into the soil pore-water. The exception to this rule is the direct ingestion of soil by terrestrial wildlife (USEPA, 2003).The soil parameters important in affecting sorption and precipitation reactions and the extent of their influence and thus contaminant bioavailability, are dependent on the intrinsic properties of the contaminants (USEPA, 2003).

Metals can exist as either cations or anions in the soil environment, which significantly affects their sorption, mobility, and solubility in soils (USEPA, 2003). For organics, lipophilicity and persistence alter their availability, as well as ionic potential in the case of organic contaminants with ionizable functional groups (USEPA, 2003).

3.2 Bioaccumulation

Bioaccumulation is the process by which an increase in the concentration of a chemical in a biological organism is observed over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down or excreted.

3.2.1 Uptake

Bioaccumulation occurs when a chemical enters an organism by ingestion, inhalation, or absorption. This is described as uptake. Bioaccumulation begins when a chemical passes from the environment into an organism's cells via uptake. Most chemicals tend to move, or diffuse, passively from a place of high concentration to one of low concentration. The force or pressure for diffusion is called the chemical potential, and it works to move a chemical from outside to inside an organism. A number of factors may increase the chemical potential of certain substances. Lipophilic, or hydrophobic, chemicals can have a tendency to move out of water and enter the cells of an organism, where there are lipophilic microenvironments.

3.2.2 Storage

Storage refers to the temporary deposit of a chemical in body tissue or in an organ. Storage is just one facet of chemical bioaccumulation. The same factors affecting the uptake of a chemical continue to operate inside an organism, hindering a chemical's return to the outer environment. Some chemicals are attracted to certain sites, and by binding to proteins or dissolving in fats, they are temporarily stored. If uptake slows or is not continued, or if the chemical is not very tightly bound in the cell, the body can eventually eliminate the chemical.

3.3 Biomagnification

Biomagnification occurs when a chemical becomes more and more concentrated as it moves up through a food chain. Biomagnification is dependent on many chemical, dietary, and environmental factors. Bioaccumulation does not always result in biomagnification.

4.0 Exposure Assessment

4.1 Estimated Daily Intake

An assumption of land crab ingestion by local residents is needed to estimate the potential for COC exposure. If a high-end consumer eats three (3) crabs per meal, two (2) times per week, and each crab weighs 250 grams on average, and that 40% of the crab is the edible portion, this results in a daily intake rate of 85 grams/day or 0.085 kg/day. For the general U.S. population, the EPA has estimated that on average people consume 20.1 grams/day for all fish and shellfish (EPA 1997b).

4.2 Human Exposure from Land Crab Consumption

The following equation was used to calculate a daily intake of land crab that would not exceed the Refernce Dose (RfD) for adults assuming an average body weight (BW) of 70 kg. The daily intake that is protective of the RfD (DI_{RfD}) was calculated for benzene, ethylbenzene and xylenes based on the following assumptions. The oral RfD for benzene, ethylbenzene and xylenes were obtained from the US EPA's Integrated Risk Information System (IRIS) database. The RfD is a numerical estimate of a daily oral exposure to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfDs are generally used for health effects that are thought to have a threshold or low dose limit for producing effects. The concentration (C) was assumed to be the maximum detected soil concentration from the effluent channel soil samples (Appendix B). Equation 1 indicates the DI_{RfD} calculation.

Equation 1:

$$DI_{RfD}\ (kg/day) = \frac{(RfD(mg/kg\text{-}day) \times BW(kg))}{C(mg/kg)}$$

Table 4-1: Input Parameters and Results of the Daily Intake Protective of RfD.

COC	RfD (mg/kg-day)	C(mg/kg)	Daily Intake Protective of RfD (DI_{RfD}) (kg/day)	Assumed Adult Daily Intake (kg/day)
Benzene	0.004	2	0.140	0.085
Ethylbenzene	0.1	8.9	0.786	
Xylenes	0.2	<2.4	5.833	

The daily intake that is protective of the DI_{RfD} was calculated for benzene, ethylbenzene and xylenes based on the assumptions noted above. The results indicate that calculated DI_{RfD} for benzene, ethylbenzene and xylenes is higher than estimated intake rates of land crab, which are conservative estimates based on a high end consumer, four (4) times higher than EPA estimates. It is highly unlikely that concentrations of petroleum hydrocarbon compounds in crab tissue would exceed concentrations recorded from soils and water based on the volatility, and tendency not to bioaccumulate.

5.0 Controls

5.1 Engineering Controls

In order to reduce the potential for mangrove land crabs to come in contact with COCs in the effluent channel area, an engineering control could be implemented. A chain-link fence installed along the perimeter of the effluent channel would prohibit crab migration to this area, reducing or eliminating the exposure to COCs in this area. The fence should be constructed high enough to prohibit climbing, and should be periodically inspected for burrows and overgrowth. It is CORCO's intent to install this engineering control under an agreement with the USEPA.

6.0 Conclusions

Based on the data provided to On-Site, and utilizing the equations and assumptions described herein, concentrations of benzene, ethylbenzene and xylenes in sediment are unlikely to result in concentrations in crab tissue in excess of the RfD. These calculations did not account for any bioaccumulation or biomagnification. The cacluations assumed that the maximum sediment concentration was the concentration in crab tissue at consumption rates that are four (4) times higher than EPA estimates.

CORCO's agreement to install a fence around the perimeter of the effluent channel will greatly reduce, if not eliminate, the exposure to land crab from the effluent channel area. The engineering control should be periodically inspected for burrows and overgrowth to prevent migration into this area.

7.0 Limitations

7.1 Uncertainty

A list and description of the uncertainties in this evaluation and the relationship between the exposure and toxicity are presented herein. Quantifying additional uncertainty due to the lack of knowledge or variability has not been included. A list and description of the uncertainties are presented in the ensuing pages.

- This report is based solely on the data provided to On-Site Environmental, Inc. by CORCO. All chemical-specific input parameters used in the models described herein were taken directly from, or assumed from the literature based on the data provided to On-Site Environmental, Inc.. The data provided to On-Site Environmental, Inc. from CORCO was assumed to be complete and accurate. If further site-specific information is gathered, or becomes available by any other means, the assumptions, models, risk characterization and assessment may need to be re-evaluated.

- This potential receptor evaluation is based on the data collected from the nearest known data points in the effluent channel area of the CORCO facility for benzene, ethylbenzene, and xylenes only.

- This potential receptor evaluation did not include any additional soil, ground water, surface water, or organism sampling. This report makes no claims as to the actual exposure to humans from consuming land crabs from in and around the CORCO facility. This report only identifies target concentrations in crab tissue for benzene, ethylbenzene, and xylenes that would be protective of the RfD utilizing assumptions described herein.

- This potential receptor evaluation is limited to the chemicals identified herein. No evaluation of any other chemicals or compounds that currently exist, have historically existed, or have the potential to be present or evaluated.

- This potential receptor evaluation is limited to the effluent channel area of the CORCO facility only.

- At the time of the site visit, a petroleum sheen was noted along the entire length of the effluent channel. A large area of petroleum-impacted soil just north of the effluent channel was also observed. Information obtained from local sources indicate that size of this release could be as much as 500,000 gallons of Number 6 fuel oil. On-Site Environmental, Inc. was not made aware of this condition until it was observed during the site visit. All assumptions were based on sediment concentration data provided to On-Site Environmental, Inc. prior to the recent fuel release.

- On-Site Environmental, Inc. makes no claims to the potential for ecological or human risk associated with the current and historical conditions in any area of the CORCO facility.

8.0 References

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The owner/operator acknowledges that subsurface conditions may vary from those encountered at the locations where borings, surveys, samples, or explorations are made. The data, interpretations, and recommendations of On-Site Environmental, Inc. may be based solely on the information available to us. On-Site Environmental, Inc. assumes that the data that has been obtained and/or provided through previous investigations represents the true conditions of the site. It is understood by the owner/operator that some of the information in this report may be second hand. It will be the responsibility of the owner/operator to review the report for accuracy. On-Site Environmental, Inc. will be responsible for its data, interpretations, and representations, but will not be responsible for the data provided to us or for the interpretation of the information by others.

Petroleum impacts were assumed to be the only contaminants on this site. A currently on-going and/or future release may change subsurface data which may invalidate the conclusions of this report. On-Site Environmental, Inc. makes no claims or warrantees regarding any agency action levels or standards and their respective or cumulative effects on the human body. Nothing in this document should be interpreted as an expert opinion regarding human health or degree of safety due to the presence of contaminants at and/or emanating from the site. Moreover, this report does not include an ecological risk assessment.

Prepared by:

Ricardo N. Alvarez, P.E./R.E.M.
President
Onsite Environmental, Inc

Appendix A - Figures

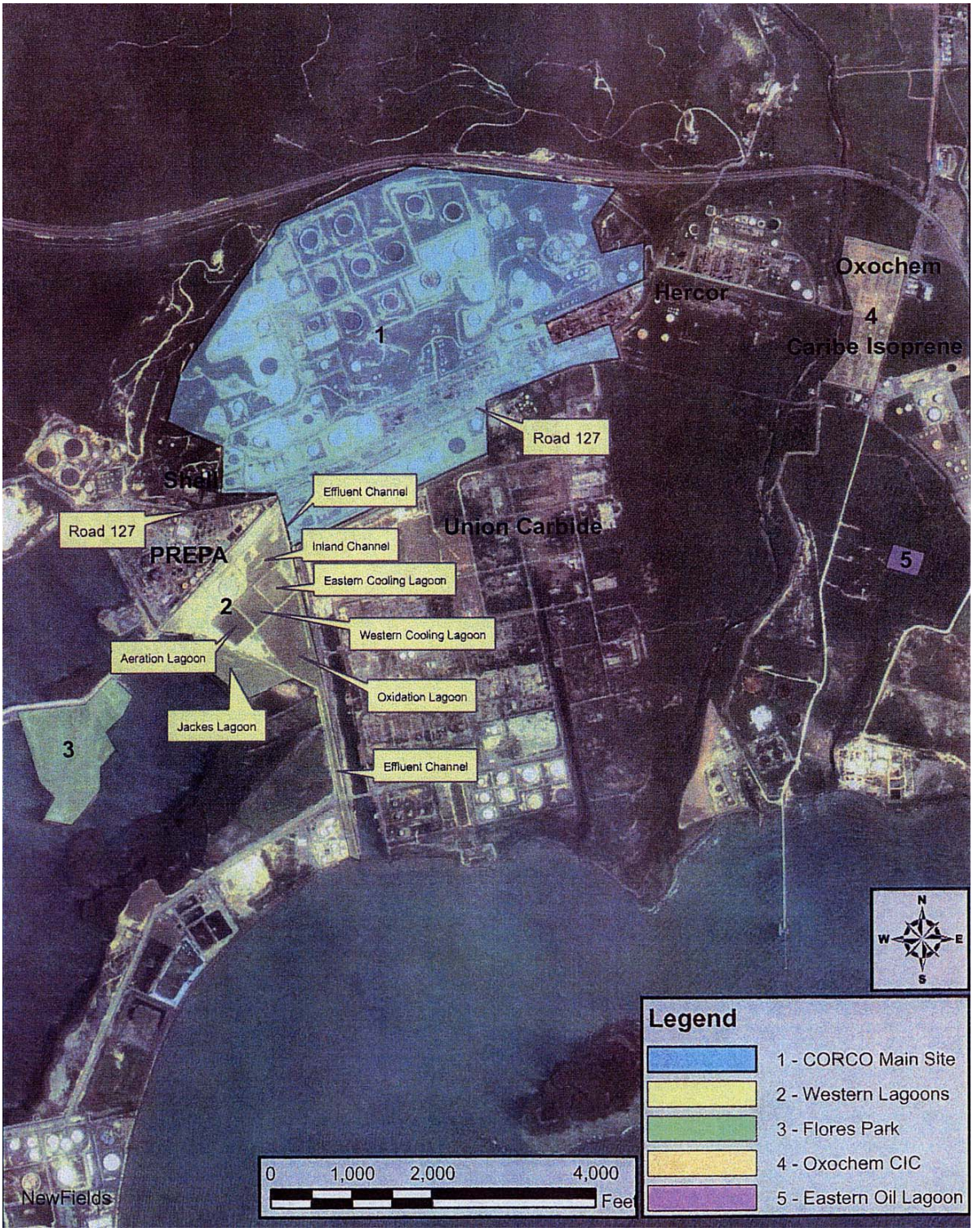

Figure A-1: Site Location Map

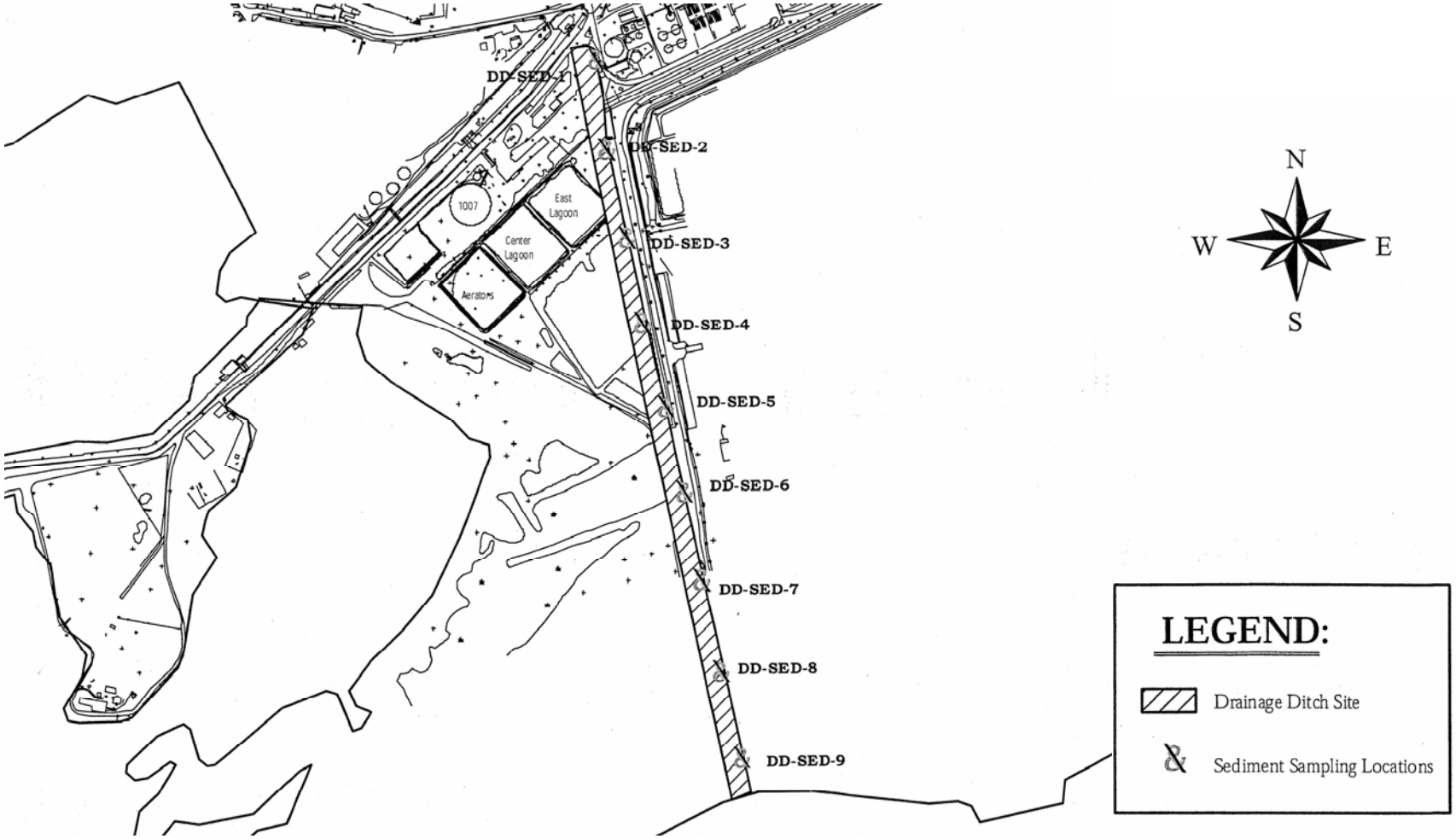

Figure A-2: Effluent Channel Sediment Sample Locations (not to scale)

Appendix B - Data Tables

Table B-1: Benzene, Ethylbenzene, Xylenes and Lead in Sediments from the Effluent Channel Area									
Inorganic	**DD-SED-1 mg/kg**	**DD-SED-2 mg/kg**	**DD-SED-3 mg/kg**	**DD-SED-4 mg/kg**	**DD-SED-5 mg/kg**	**DD-SED-6 mg/kg**	**DD-SED-7 mg/kg**	**DD-SED-8 mg/kg**	**DD-SED-9 mg/kg**
Benzene	<0.010	<0.024	2	<0.440	0.14	<0.012	<0.011	<0.007	<0.008
Ethylbenzene	<0.010	<0.024	8.9	1.1	1.6	<0.012	<0.011	<0.007	<0.008
Xylenes	0.074	0.04	<2.4	0.098	<0.520	<0.012	<0.011	<0.007	<0.008
Lead	38.4	45.7	90.8	110	93.5	36.7	33.1	41.5	17.1